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ORIGINAL PAPER

# The role of story and place in Indigenous science education: Bigfoot in a youth-designed ecological restoration plan

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**Abstract**
This study explores some of the ways in which the dominant science education system in the United States suppresses Indigenous knowledge systems and privileges Western knowledge. Using anti-oppressive inquiry through critical self-reflection, this study is situated in experiences I have encountered as a non-Indigenous doctoral student, curriculum developer, educator, and budding educational researcher on a 3-year STEM education project with Native youth in two tribal communities in the Pacific Northwest. I describe the cultural tensions experienced between project stakeholders in attempting to plan and implement a culturally-relevant curriculum dominated by Western STEM, and how a pivotal moment in which youth incorporated Bigfoot stories into a stream restoration activity challenged my awareness of this paradox. Therefore, Bigfoot became my teacher in provoking my recognition and appreciation of Indigenous knowledge systems, the role of communal narrative in Indigenous education, and the importance of displacing cognitive imperialism. This study adds to the dialogue that science education must be accessible for diverse learners, including culturally-appropriate and culturally-relevant pedagogies and curriculum, by challenging the status quo of hegemonic knowledge in the dominant system. Indigenous knowledge provides place-specific and contextually meaningful insights about the natural world, which is shortchanged if not provided consideration in its role within science education. As a result, this paper provides a space to consider how acknowledging and accepting diverse knowledge systems as ways of understanding the natural world, including those outside of the dominant system, provides a more holistic and meaningful approach to science education.

**Keywords** STEM education · Culturally-relevant science curriculum · Place-based learning · Indigenous knowledge

This paper provides a critical self-reflection about how I, the lead author, came to understand the privileging of Western knowledge systems and suppression of Indigenous

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knowledge systems and pedagogies in the dominant education system of the United States. This reflection is situated in experiences I have encountered as a non-Indigenous doctoral student, curriculum developer, educator, and budding educational researcher on a 3-year National Science Foundation-funded STEM education project with Native youth called Back to the Earth (BTTE). The project was an educational initiative that partnered with two local tribal communities to provide culturally embedded STEM camps and learning opportunities for youth in each community. The first year of the project exposed tensions arising from an unequal distribution of power in curricular decision-making and what constitutes as acceptable forms of knowledge in educational platforms. Using anti-oppressive inquiry (Potts and Brown 2015), I describe how I came to experience a growing cultural understanding of science education within the two tribal communities, including an epistemological view of coming to know the natural world through story.

The mysterious creature Bigfoot is of central importance to this reflective study, as he ultimately provided for my understanding that knowledge systems are situated in culturally-significant and specific context. Bigfoot, also known as Sasquatch, is an elusive large and hairy bipedal ape-like creature of North American folklore. Stories about Bigfoot are prominent in many Indigenous tribes of the Pacific Northwest and British Columbia, although similar creatures have been described in regions throughout the world. Note that although I represent Bigfoot as a singular male based on how he was represented to me in communal stories and representations during the summer camp activities, many Indigenous stories refer to Bigfoot according to both male and female sexes, as well as in singular form or family and communal units.

Much like Bigfoot's concealed and enigmatic existence, teachings of place-based and culturally-specific knowledge were revealed to me unexpectedly through tribal stories and student representations of knowledge. These experiences brought me to realize that I was not only privileging the knowledge system of my Western dominant culture, but that I was simultaneously suppressing knowledge systems that differ from my own. Stories of Bigfoot reveal that he is a mirror of human needs: He coexists with us and relies upon many of the same resources. Thus, it is wise to consider his needs in addition to our own for a harmonious coexistence. In this paper, I outline how Bigfoot became my teacher in provoking my recognition and appreciation of Indigenous educational needs, including Indigenous knowledge systems, the role of communal narrative, and the importance of displacing cognitive imperialism (Battiste 2013). I do this through sharing a series of vignettes that describe the power dynamics and cultural tensions that ensued from designing culturally-relevant STEM curriculum, the appearance of Bigfoot in stories and student work, and my lack of understanding of how to analyze Bigfoot in the data.

Bigfoot may be considered by some to be an outlandish and unconventional teacher of science education and anti-oppressive inquiry, however his teachings were revealed to me through communal stories shared at a STEM camp for Native American youth during the summer of 2013. During the summer camp, tribal community members engaged the youth with stories of Bigfoot throughout the week and during various cultural and STEM activities of the camp. While I understood that the youth were entertained and captivated by these stories, I did not understand that the stories carried substantial meaning. Rather, I dismissed the stories as merely that—just stories. However, after I began to recognize the inclusion of Bigfoot in student-created physical models of a stream restoration plan, and again during research analysis, I came to understand that the stories provided teachings unique to epistemology and ontology of place. As such, this paper is an analysis of how Bigfoot came to symbolically represent my recognition and respect for multiple knowledge systems in two ways: (1) stories are a vital component of Indigenous education in that they

transmit layered, multi-dimensional knowledge unique to place, community, ecosystem, values, and communal and personal identity; and (2) the dominant culture privileges Western/Eurocentric knowledge systems and modes of education while eschewing, dismissing, and/or ignoring other knowledge systems, in this case Indigenous knowledge systems, and especially those shared through stories.

Stó:lo scholar Jo-Ann Archibald emphasizes and legitimizes the process of *storywork* as a multilayered synergistic, holistic, and culturally-based teaching practice (2008). Archibald states that stories encourage us "to think deeply and to reflect upon our actions and reactions" (Archibald 2001, p. 1). This statement speaks not only to traditional Indigenous stories such as myths and tales, including the one in which I learned about Bigfoot, but also the stories we personally experience in our everyday lives. These lived stories provide an opportunity to think deeply and reflect upon the lessons that endure through such experiences. For this reason, I wish to share my own story through a series of vignettes of how I came to experience the cultural tensions encountered in an educational partnership that interrupted my ignorance of epistemological dominance. I share this story with the intent of unearthing and analyzing my actions and reactions toward these cultural tensions as a means of opening dialogue about our personal responsibilities to acknowledge acts of oppression.

Furthermore, I wish to tell this story as a vehicle for conveying the important role of story as holistic pedagogical approach for culturally-responsive education. While I previously understood that stories are captivating and often portray valuable lessons, I was ignorant to see how they transmit culturally-centered knowledge, values, and beliefs that transcend the story itself. This may seem obvious to anyone who has heard a traditional story, but when centered in the context of science education or applied science, takes on an entirely new meaning. Thus, I share how Bigfoot's appearance in youth designed stream restoration plans slowly revealed the power of story as a mode of culturally-based STEM education.

Although this story is based on my own personal experiences, it is important to note that my story is only one of many woven together. All stakeholders involved with this project have their own story to tell and I do not wish to further hegemonic dominance by positioning my voice over theirs. However, I chose to tell this story based on lessons of humility; that in order to confront and resist oppression, we must first look at ourselves. For this reason, I use Karen Potts and Leslie Brown's (2015) anti-oppressive inquiry to explore these actions and reactions of my roles in the process.

According to Potts and Brown, anti-oppressive theory is a post-structural and postcolonial extension of Marxist, feminist, and critical theories. It addresses the political practices of creating knowledge and how contributions toward oppression occur through privileging identities and/or knowledge. Thus, drawing from Potts and Brown's theory, anti-oppressive inquiry is comprised viewing research through the lens of the following three tenets:

1. *Social justice is resistance in process and outcome* In other words, efforts toward social justice are not limited to the end goal; it is always in process. We must first challenge ourselves within the greater context of the status quo by continually reflecting on our process to challenge and transform the enterprise of education, as encouraged by bell hooks in *Teaching to Transgress* (1994).
2. *All knowledge is socially constructed and political* Knowledge is an epistemological product of people and their interactions, and is positioned with biases, privileges, and power relations. Thus, truth is pluralistically created rather than existing as a singular

external phenomenon. Knowledge can be used for oppression or resistance depending on how it is constructed or utilized. Anti-oppressive inquiry seeks meaning and understanding rather than truth.

3. *Research projects elicit complex power relations with those involved with the research* Knowledge is about power and relationships between "the knower and the known, groups of knowers, knowers and any outside researchers, researchers and external institutions" (Potts and Brown 2015, p. 263). With this said, researchers and the researched must examine the power relations between them and shift power to those being researched.

Through this anti-oppressive lens, I will examine the experiences I encountered in my various roles throughout the Back to the Earth STEM project for meaning and understanding of the following questions:

- How are stories important in Indigenous education? Specifically, how did Bigfoot stories reveal learning opportunities for youth and myself?
- How was I suppressing the knowledge systems shared through story as a curriculum developer, educator, and researcher?

## Culturally-relevant STEM education

Educators and advocates have long demanded that STEM education (science, technology, engineering and math) must be accessible for diverse learners, including culturally-appropriate and culturally-relevant pedagogies and curriculum (Lynch 2000). With respect to political and economic security, it is estimated that 75% of the fastest growing jobs will demand STEM skills, including the analytical, problem solving, and creative processes associated with it (Hackling 2016). Apart from the need to rely upon a specialized STEM work pipeline, society as a whole will require the "curiosity and imagination to be part of the broader STEM economy" (Office of the Chief Scientist 2014, p. 21). However, evidence suggests high rates of failure and departure from STEM academics and careers, most prominently amongst people of color (Museus, Palmer, Davis and Maramba 2011). Although it is apparent that STEM education for all students is urgently in need of attention, Native Americans are among the most poorly represented demographic in the STEM fields (National Science Foundation 2017). With respect to tribal sovereignty, this lack of representation is especially concerning as a matter of tribal political, economic, and most importantly land security. In other words, for Indigenous people this is a matter directly affecting communities: it goes beyond national political and economic concerns and impacts the wellbeing of communal life on Indigenous lands towards Tribal sovereignty, natural resource management, and stewardship. Certainly, this call for culturally-relevant education is paramount under such conditions.

However, what is more ambiguous is what culturally-relevant education looks like for Native students, particularly when embedded in mainstream education. Although a vast literature pool exists on various theoretical aspects of Indigenous education, mainstream education largely attempts to address cultural relevance for Native students by means of an "Indianized" approach (Grande 2015, p. 60). In other words, curricula typically maintains a Western dominated focus without discussion of critical theory. Instead, surface-level cultural elements are inserted in the standard curriculum with attempts to make education "relevant". Some of my Native colleagues have referred to

these attempts as "slap-a-feather-on-it curriculum" (E. Rasmussen personal communication, May 2015) to emphasize how these curricula are not Indigenized but rather tokenized. With that said, the question remains in how to effectively Indigenize rather than "Indianize" education. Indigenous scholars challenge these approaches by advocating for Indigenous education to vanquish the cognitive imperialism of mainstream education (Battiste 2013) and examine knowledge-power relations (Bang, Warren, Roseberry and Medin 2013). In other words, the entire education system must address the colonial stronghold on education. As this is recognized, education can become increasingly Indigenized by opening spaces for more holistic, monist, and communal practices (Aikenhead and Mitchell 2011) and by including story as more meaningful modes of learning (Cajete 2015).

The cognitive imperialism of mainstream science education is rooted in European history of the Enlightenment period and the Scientific Revolution. As such, objectivism, positivism and Cartesian Dualism form the basic tenets of understanding the natural world through modern science. It is important to note that this science has been used as a force for subjugating lands and relegating its inhabitants as resources throughout periods of exploration, exploitation, and colonization (Weeks 2002). Certainly, the approaches to knowing about the natural world for many Indigenous peoples differ from that of the Western mode of inquiry. Rather than understanding the world out of domination or control, Indigenous knowledge of the natural world is land centered and inextricably tied to the interconnectedness of all of its inhabitants. Yupiaq scholar Oscar Kawagley proclaims, "It was meaningless for Yupiaq to count, measure, and weigh, for their wisdom transcended the quantification of things to recognize a qualitative level whereby the spiritual, natural, and human worlds were inextricably interconnected" (Kawagley 2010, p. 90). The point of this paper is to not explore the intricacies of such differences but instead to recognize that the settler colonialist discourse of the mainstream educational model imbues a particular approach and worldview that differs from other knowledge systems, and that this dominant system often refuses to acknowledge that such differences exist. As a result, the knowledge systems of the dominant are privileged over any other, resulting in the oppression of anyone who adhere to the epistemologies and ontologies of their culture.

Before my experiences with the Back to the Earth project, which I will describe in the following paragraphs, I was unaware of the privilege and dominance associated with my entrenched knowledge system. Although I may have understood that different epistemologies existed, I was not aware at how much I had personally privileged Western knowledge systems until it was challenged. The tensions of these differences will be presented in vignettes of my experiences as a Non-Indigenous settler and member of the university team working with our tribal partners throughout the curriculum planning, implementation, and research of this STEM project with Native youth in tribal communities. These vignettes, and the analysis of their meanings, will include information from meetings with community members and the core university team, meeting notes and minutes, reports and handouts, curriculum documents developed for the summer camps, recorded video, field notes, and self reflection. These data sources are considered by myself a gift, and include the seeking, listening, and learning that accompany the process of meaning-making and understanding. It is my hope that these stories, reflections, and meaning-making will invite educators within the dominant system to engage in reflexivity with their own practice. I hope that educators question their own relationship to knowledge (i.e. the privilege associated with knowledge, how it is constructed and utilized, and the pressure to maintain its dominance) while encouraging educators outside of the dominant system to resist cognitive imperialism through foregrounding their own knowledge systems.

## Vignettes

### Culturally-relevant curriculum development and implementation: a story of privilege and selective hearing

This story is told in the context of my experiences with a 3-year STEM camp called Back to the Earth (BTTE). This NSF-funded project was a partnership between two tribes in the Pacific Northwest and a local land-grant research-intensive university I attended for my doctoral education. BTTE offered informal culturally-embedded STEM learning opportunities, most notably through summer camps, for students in the 4–8th grade and camp mentors in the 9–12th grade. The overarching theme of these camps was a shared watershed between the university and the two tribal partners. Our university team comprised of non-Indigenous settler professors and graduate students trained as Western scientists, engineers, and educators. I was involved with the university team as part of my stipulation as a graduate student with this institution, bringing in my background with biology and environmental education.

Before I continue, I must tell you about myself so you can understand my position in the project and how I came to work in this setting. I grew up in a typical, mainstream suburban American family in which I always had an interest in science. I applied this passion in my educational pursuits and obtained both Bachelor and Master of Science (MS) degrees in biology. During my Masters, I worked as a field technician with a nearby tribe collecting data for a habitat restoration study during which I became more aware of the sovereign management of Native lands. I completed my thesis with this tribe looking at relationships between Native and invasive aquatic species. However, I also became aware that non-Native individuals like myself held most of the tribal scientific management positions. It seemed to me a great paradox that the sovereign management of tribal lands was held by non-tribal individuals, which led to my interest in Native peoples, or lack-thereof, working in the scientific pipeline.

After completing my MS, I began to teach introductory science courses for non-majors at two universities in the same region. One of these jobs led to a full-time position at a Jesuit institution that included teaching a lab science to elementary education majors and coordinating a science outreach program with local elementary schools. Because of the historical underpinnings with Jesuit missionaries and Native American education, the institution continues to maintain attempted relationships with tribal communities. However, these relationships are complex and contested. From my own perspective the relationships put forth by this Jesuit University, at least in my department, seemed somewhat disjointed and lacking the desired impact. For example, Native high school students would reside on campus for a few weeks during the summer to research alongside science faculty members. While seemingly a positive experience, the research was arguably incongruent with student's lives since it branched from faculty research rather than scientific topics of interest to the student. Furthermore, I knew we had a few Native students on campus and they did not maintain the same retention rates as their white peers, but I was perplexed as to the reasons why. These observations prompted my interest in the barriers that exist for Native students in higher education.

I chose to leave my position with the Jesuit University and reassess my future plans after welcoming a new baby and feeling that I had reached a dead-end without a Ph.D. A few months later, the Principal Investigator of the Back to the Earth grant invited me to be involved with the project as a Research Assistant in conjunction with a Ph.D. program.

Given my previous experience with habitat restoration on tribal land as well as my interest in science education, I agreed.

The journey with the BTTE project began in the spring of 2012 at a retreat in a tribally owned and operated casino and resort center with the core university team and stakeholders from each identified tribal community. The purpose of this retreat was to gather input and organize collaboration on a vision for the project. This retreat first opened my eyes to the road that lay ahead of me and revealed elements that suggested I would be pushed out of my comfort zone to reflect on my own privilege and experience with oppression and power. For example, the retreat began with presentations about the history of how Native lands were allocated to non-tribal members and the subsequent ramifications on the culture and wellbeing of the tribes. While the presenter was a white woman who works for one of the tribes in the BTTE program and is greatly respected, another retreat attendee later came to her to tell her about the transparent "white guilt" she emanated through the presentation. Although I did not directly witness the conversation, I heard about it through a back-of-the-room discussion.

> Between feelings of humor and offense, I was surprised that something that was couched in historical fact was perceived as carrying a racial guilt. Nevertheless, the memory stuck. Did it stick because I hold on to some level of white guilt myself? Or is it because I wonder if a white person can be a legitimate ally to American Indian people without being viewed as attempting to cover up or hide the sins of historical mistakes? Is this work - science education research with American Indian children - something that I can appropriately and fairly do as a white woman?

Later in the retreat there was a planning discussion about the project and how it should be implemented in the communities. There was a heavy feeling of tension in the room, as though parties were attempting to say what they needed to, but weren't being heard. A female tribal member pulled the group together and opened up a prayer to the Four Directions to ask for guidance. She did this by singing a loud and powerful song, rotating her body with each of the Four Directions, including the sky and the earth in her movement. Her voice boomed through the room and down the halls. It wasn't just heard—it was felt.

> As a Westerner, this was shocking. I wondered if the casino patrons playing the slot machines below our conference room could hear her and what they were thinking as her voice reverberated through the walls. I wondered how other retreat attendees perceived it as well. Was this normal? For me it was both awe-inspiring and awkward at the same time. I didn't quite know how to react, but I could tell it was serious so I let myself be awkwardly immersed in the moment with my full respect and attention.

As time progressed after this initial retreat, we moved into the curriculum planning by holding several meetings with tribal members invested in the project. Our partners stressed the importance of having culture be the cornerstone to all of the camp activities and themes rather than as a mere "add on". They articulated that cultural preservation was at the center of their work, and that their ancestors were people of sophisticated thought. They also informed us of many ways their ancestors used STEM throughout their seasonal cycles, one example being the design, construction, and use of fish weirs, and their desire to include that as an engineering component of the camp. Although I recognized the application of the fish weir as fitting within the scope of STEM, I recall my overall sentiment being that the tribal partners wanted a culture camp rather than a STEM camp.

This attitude, along with a lack of understanding of knowledge systems outside of my own, led me to privilege my scientific knowledge as superior to tribal knowledge. Although

I did not see tribal knowledge as invalid, I did not have enough understanding of the tribal communities or their culture to understand how it worked. I only had my own culture to compare it to. Upon reflection, I now see that I was in no position to understand how the tribal cultures were to be at the center of the curriculum. I couldn't see it because I was playing on the border—but mostly staying within the comfortable confines of my own border. I only understood the science that I knew and identified as legitimate science. This was revealed during one of the early community meetings in which I learned of two rare amphibian species in a tributary stream near one of the reservations. I had complete enthusiasm and mentioned that we needed to include a visit to this location for the purposes of comparing "pristine" habitat with "degraded" habitat. I mentioned this after one tribal member had finished explaining her community's vision for the camp that included the ecosystem dynamics of beavers and their ability to use ecological engineering to restore streams and wetland habitats. Through her body language, I could tell that I demonstrated that I was not listening or respecting her input. I dismissed her ideas and that of her community, at least outwardly, for my own. In other words, I gave my ideas power over hers. I legitimized the science I wanted to include in the camp over what her community valued. After this encounter, I learned the community was beginning to grow outwardly frustrated with us; they figured it didn't matter what input they gave because we would do whatever we wanted to anyway.

Although my experiences leading up to my participation in the BTTE project provided me the initial interest of American Indian success in STEM fields, my first encounters with our tribal partners demonstrate that I held an extremely limited understanding of Indigenous ways of knowing. Furthermore, I was unsure of my role as a white woman in a research position with Native people. As a result, I was not at a place, cognitively or emotionally, to fully comprehend the messages being conveyed by our tribal partners during the early stages of our partnership. I interpreted discussions about the summer camp curriculum to mean that the university team would take care of the STEM components while the tribes would take care of the cultural components. Even after tribal partners demonstrated their expertise in STEM content as related to their community and provided many attempts to describe ways culture and STEM are intertwined, I misunderstood their dialogue as a request for a "culture camp" disguised as a STEM camp. It was not until I was immersed in the analysis of the student data of the first summer camp that I had a personal revelation in how cultural practices embody STEM.

Our team, myself included, was driven to provide a camp experience rich in (Western) STEM content and experiences. We saw this as a fulfillment of the grant and a necessary component of a STEM camp. The first year that BTTE was implemented, 2013, was arguably the most difficult due to tensions with this vision. Although our tribal partners repeatedly attempted to express the importance of genuine cultural integration in the curriculum, warning that culture must be considered first and foremost, the university team did not seem to understand what was being conveyed.

I attribute the following three factors to this lack of understanding: (1) *Perceptions of Expertise*. Following Western social protocol, the university team identified with our professional roles and highlighted our expertise. We did not acknowledge the expertise of tribal members in the same way, and by doing so we assumed a position of power and rank. The tribal communities later stated that they did not care *what* we were, but rather *who* we were. In other words, we did not approach the partnership with an understanding of building genuine relationships with the community, but as self-appointed advisors. Our expressions of expertise needed to be humbled in favor of exposing ourselves as people who can learn from and respect one another. (2) *Grant Accountability*. The university team

assumed responsibility for the accountability of the grant. We had agreed to deliver a series of STEM camps to both tribal communities with funding from NSF, thus the university team experienced tension in appeasing both the tribal partners and the grant-funder. Our Western interpretation of STEM pressured us to adhere to that responsibility by delivering the camps accordingly. (3) *Epistemological/Ontological Ignorance.* The university team was so entrenched in our own culture, that it was difficult to comprehend or be open to the meaning of Indigenous culture. This factor has arguably been the most difficult to address because it cannot be didactically taught to outsiders like ourselves, especially in the short timeframe of a 3-year grant project. Although we depended on our tribal partners to help us understand their culture and the STEM embedded within it, it is ultimately the relationships and spending time in the community that provides these opportunities to open epistemological and ontological awareness. This of course, takes time.

Because of these three factors, a very Western scientific approach was taken with the curriculum design and implementation during the early phases of the project. Despite the warnings, cultural aspects were in fact merely added on the side. For example, the entire approach of the first BTTE camp curriculum was to scientifically determine the problems associated with a culturally-significant creek: students collected data on erosion, water temperature, stream morphology, and presence of non-Native species. "Cultural activities", as we initially called them, were incorporated and included building and installing a fish weir, telling stories, and going on a hike with an Elder. Although these cultural aspects were included, the university team maintained an emphasis and importance on the Western STEM. There was little integration between the activities that acknowledged or privileged Indigenous STEM or other Indigenous ways of knowing.

It could be argued that the university team attempted to create the curriculum by cherry-picking the cultural components shared by the tribal partners that seemed to fit within pre-existing ideas of what Western STEM would be included. The university team was immersed in our own understanding of the dominant system, and sorely unaware of the worldview of our partners. Our understanding of place was one of geographical location in which humans interact with the environment. Although we attempted to adopt David Gruenewald's (2003) theory of place, in which we would attend to the perceptual, sociological, ideological and ecological aspects of place, we seemed to only acknowledge that "places teach us about how the world works and how our lives fit into the spaces we occupy" (p. 621). Although Gruenewald discusses the political dimensions of place, including the impacts of colonialism and marginality, we failed to understand how these factors impact place and the people in them. Instead, we saw the curriculum as a means of using place as a context with which to do Western STEM and have it somehow be meaningful because it has been identified as culturally important. We thought youth could build perceptual dimensions by directly experiencing the place through structured activities and unstructured play. We sought to enhance sociological dimensions by interacting with peers, community members, and the university team. Ideological dimensions were promoted through "cultural activities" and studying how land use has changed over time. Finally, we explored ecological dimensions through learning about flora and fauna in the place. While these opportunities were meaningful to a certain degree, the curriculum lacked the depth that a substantive place-based curriculum is supposed to provide: an opportunity to reflect on how place impacts individuals/community and how individuals/community impact it (Bang, Curley, Kessel, Marin, Suzukovich III and Strack 2014). As a result, the youth attending the camp went from one activity to another without having the meaning of place successfully woven within these contexts. The tribal community attempted to provide these opportunities throughout their involvement, but the university team overshadowed them by

privileging the Western STEM activities instead. This, of course created tensions between the university team and the tribal partners.

A pivotal moment occurred on the last day of the camp, however. Although the university team and the tribal community were at odds with the implementation of the curriculum for the reasons described above, the youth managed to weave the experiences together and open the doorway toward Indigenizing the curriculum themselves. They integrated the Western STEM activities and the "cultural activities" together in their final activity in a holistic and meaningful way, of which I will now describe.

## Bigfoot in STEM: community-based stream restoration

On a Thursday morning in June of 2013, a group of 4th–9th graders gathered inside a cinder block building on a cool, gray, drizzly day. It was the last day of their 4-day STEM summer camp, and we all had just feasted on a salmon lunch after listening to an Elder speak about the heart being an important guide in the "Indian ways" of scientific understanding. The students' attention was now focused on several plastic caddies holding various natural materials and shallow plastic trays filled with flattened clay. The students received instructions for a creative activity in which they were to design a restoration plan for the creek they had encountered throughout their week of camp via scientific and cultural activities. The students were to use the data they had gathered about the creek to determine the most pressing environmental challenges in and around the creek including:

- water quality analysis
- streamflow patterns and stream shape
- macroinvertebrate biological indicators
- substrate composition
- electrofishing sampling of fish species inhabiting the stream.

Through this data analysis, students could address solutions to these problems by designing an environmental engineering plan that they would demonstrate in a three-dimensional physical model. The clay in the shallow trays represented the landscape surrounding the creek, while a barren straight line in the middle of the tray represented the creek. The caddies contained materials they could use in their design plan such as sticks, rocks, gravel and lichen as well as pipe cleaners and toothpicks. The students had to explain how each change was implemented in the model as if they were in the model themselves. In other words, they were not to just place rocks in the model, they had to describe how those rocks got there according to their design plan.

The kids began to mold the clay into meandering river banks, place gravel in the stream beds, line stream banks with lichen, put boulders in and around the creek, and place hay bales on empty creek banks. Chatter about fish, erosion, and dissolved oxygen took place and discussions about where to plant trees and how to keep cattle out of the stream could be heard amongst the excited exchanges. The students used their scientific knowledge of the creek's environmental concerns to propose and refine solutions through the creation of their three dimensional model of this creek.

As I moved around the room, I noticed a hominid figure made of black pipe cleaners appear in the corner of one group's model. The figure held a spear in one of its arms and a fish in the other. A fish weir stood across each bank in the creek below. A drying rack with pink pipe-cleaner fish hanging below it stood in the other corner. In another

group's model, a fire pit and fish rack were twisted out of pipe cleaners and placed in the model. It too had a fish weir in the creek and a hominid figure perched on the represented land above the creek. Although the kids were engineering the creek to be more environmentally sound with scientific knowledge, they were also creating an ecosystem in which they were coexisting members. What I observed in that exercise was that students were apparently doing a lot more than merely objectively manipulating the environment: They were situating themselves in the place.

Throughout the week of camp, youth collected scientific data along the creek, but they also engaged with community members in traditional and cultural ways. They listened to stories about what the rivers used to be like before the hydroelectric dams were constructed, how their ancestors were River People who harvested 90-pound salmon and other aquatic species for food, how fish weirs were designed and erected in the rivers to capture and harvest fish, and about how Bigfoot would come down from higher ground to steal fish out of the weirs at night. Students would listen to these stories in the warmth and intimacy of a tipi set up near the creek, by the morning fires, or along the creek banks during activities. In addition to collecting data, the students were collecting stories and both were influencing the youth's design plans.

## Challenging research with a Western lens: Bigfoot in data analysis

After the 2013 summer camp had ended, I reflected on the final stream restoration activity as a tremendous feat of scientific understanding and application for the youth. Youth seemed to be able to successfully identify and apply several complex systems-level concepts with ecology and environmental engineering to identify problems within their creek (e.g. erosion, high water temperatures, high dissolved oxygen, low substrate diversity) and design solutions (e.g. erecting fencing to keep cattle from trampling creek beds, placing hay bales along creek banks, planting riparian shrubs for shade, increasing gravel spawning beds for trout). They appeared to translate data into action and problems into solutions, which was the intent of our STEM curriculum. It was now time to start looking at the data presented through the camps.

I initially looked at videos of student presentations, transcripts of the presentations, and artifacts of the student models and began to code and analyze for identification of environmental/scientific concerns and proposed solutions. I wanted to find a way to analyze the student representations of their knowledge through their model designs, and began to do so by creating a rubric. This rubric was developed to identify and quantify the level of representation in each of the following categories: identification of environmental/scientific concerns, evidence of reasonable and justifiable design solutions, and evidence of human interactions within the ecosystem (i.e. cultural representations). Ratings in the identification of scientific concern and solution ranged from zero to four, with zero indicating factors were not included or addressed in the model or data, while a rating of four indicated factors were included in the model or data along with an explanation of the problem/solution and includes a clear rationale for sources and impacts of concern. Human impact data were reported as being present or not present, with the rater being able to provide additional open-ended comments on observations.

### Analysis of student physical models

Members of the university project team (seven researchers, including two community liaisons, one a tribal member) rated the student physical models using the provided rubric. First they were given the rubric to analyze one model from each community. During this analysis the team was asked to pay particular attention to the following:

I. Holistic representation of the model,
II. Evidence of identification of riverine environmental concerns,
III. Evidence of engineering applications and
IV. Evidence for human interactions within the ecosystem.

After each researcher analyzed the two student models, the researchers came together to discuss their analysis and negotiate development of a final rubric. During these negotiation meetings, the main concern was in each researcher's ability to assess the most effective or assumptive criteria and "read" into the static models. While the research team felt they directly observed evidence of "Erosion control" such as planting of vegetation and ground cover on the banks of the mock creek, evidence of deliberate sites of "Food for fish or other animals" or areas of increased "Dissolved Oxygen" were more difficult to observe on the models themselves.

Even more difficult was the ability to assess the holistic representation of the models, particularly as they related to the ontological and epistemological aspects students used to inform their designs. As Western researchers, we were unable to understand the epistemological and ontological aspects that might influence youth's designs due to our own positioning, but also because we were unwilling to acknowledge that positions outside of Western STEM might influence the designs to the degree they did. We did not ask the students to consider factors beyond Western STEM in their design plans and instead only asked youth to consider the data sets from their fieldwork.

While not understood immediately, this narrow focus limited the university team's ability to recognize the holistic aspects of the students' design plans. For example, when university team adult educators interacted with youth during the building phase of their model design, they asked youth to describe the Western scientific and engineering elements of their designs. For example, adults would ask, "what did you do to address sediment?" or "why did you build a fence there?" During such questioning with one group, students explained their justification for controlling temperature and dissolved oxygen with planting shrubs and grasses and then added, "Oh, and we made a Bigfoot!" The adult did not acknowledge that Bigfoot contributed to the design with any probing follow-up questions, but instead continued asking about problems and solutions that were instead privileged in the camp curriculum. Students were not given an opportunity to explain why Bigfoot was in their models, because it did not fit within the university team's understanding of science. This presents problems with the data analysis since this aspect was essentially dismissed in the rubric.

Another reason for the difficulty in assessing the holistic nature of the models may be the reductionist nature of the rubric alone. We had already used it to compartmentalize aspects of the model according to the STEM categories listed. Even though the researchers may recognize the sum is greater than its parts, we were unable to categorize beyond the parts. The following excerpt, a description of the model written by its student designers, is provided to highlight an example of this challenge:

> We wanted to live in a more cultural place, so we went to explore the area we didn't know. Then we found T. Creek. We realized it was an unhealthy habitat. We decited [sic] to live here and clean it up.
>
> We put some dirt on places were [sic] the creek was already flowing and dug some holes so the straight creek could meander. We planted trees so there wouldn't be a lot of eroision [sic]. We had to chop some trees down to make houses so we put hay down to stop the erosion. There was still some bare dirt around the creek so we planted grass.
>
> We lifted rocks heavy as we could, we put them by the creek to make habitats for the fish. We reaslised [sic] we needed to eat, so we built a fish wear [sic] (weir). So we also built a fish hangers with fire under it. Bigfoot took the fish home and ate some. We found tracs [sic] so we built croad [sic] (crawdad) traps.

The example illustrates that the youth were modeling a direct interaction with their ecosystem in that they were inhabitants of their ecosystem. They indicate a level of dependence and consideration for the organisms in their ecosystem in addition to mere identification of problems and seeking solutions. The inclusion of cultural elements, such as food collection and preservation, "living in a more cultural place" as well as including Bigfoot, were more difficult to assign to a rubric category.

> I recall wondering what to do with Bigfoot. Where did he fit into the rubric? Was he considered a cultural icon or a human interaction? I certainly didn't consider him a part of STEM, so I could just plug him somewhere in the open-ended culture category…but why did the youth include him? What did he have to do with stream restoration? Did the kids like the stories that much?

Ultimately, the challenge was the rubric only allowed us to analyze the knowledge systems that our university team privileged from the project's inception–Western STEM and Western research. Additionally, the rubric itself was a Western tool designed by the university team, analyzed almost exclusively by the university team, and used to analyze the university team's effectiveness in teaching Western STEM concepts, arguably a way to pat ourselves on the back for a job well done. Potts and Brown suggest that anti-oppressive researchers ask themselves who does the analysis, what concepts frame the analysis, who benefits from the meaning making, and what analytic tools are appropriate. I think it is apparent that the university team had a heavy influence and advantage in each of these aspects of analysis and meaning making, leaving our tribal partners in the margins.

After attempting the rubric and realizing its limitations, the inclusion of Bigfoot in the models continued to haunt me more than anything else. I still wondered why the youth not only inserted him into their models, but included him as a key feature during their presentations. I could understand fish, crayfish, and even fish weirs and drying racks. Those were natural resources or tools that had direct application in harvesting and preserving those resources. However, Bigfoot almost seemed to be a competitor—an enigmatic figure that could take those resources and leave the weir in disrepair.

At some point, I began to understand that the youth were restoring the creek with the full community in mind, not just restoring natural resources or manipulating a culturally-meaningful environment to health as we had intended them to do. Community in this case means all that are a part of the land and include the natural and human community as well as the mysterious. Glen Aikenhead and Herman Michell (2011) state that Indigenous people "celebrate mystery and living in harmony with the mystery in

the inner and outer spaces of existence" (p. 81). It is considered an act of humility to acknowledge that there are many unknown mysteries about the natural world, yet remain aware that these mysteries are also part of the interconnected web. The stories about Bigfoot shared at camp acknowledged this mystery in that much is unknown about Bigfoot, but also give notice that he depends upon the same resources as humans. Bigfoot depends on the stream just as much as humans do. He is part of the community, thus part of the restoration plan.

## Bigfoot stories as a pedagogical approach

As described above, the students included Bigfoot in their models, notably the subject of some of the stories told to the campers by community members. According to the tribal stories, this creature lived (and possibly still does live) in areas of higher ground beyond the creek, had a horrible stench, and periodically raided fish out of the weirs at night. These raids would leave the weirs of the youths' ancestors in disarray and reduce the harvest of fish, particularly Salmon, to feed the tribe. Therefore, their ancestors had to repair the weirs and restart their fishing attempts after such events occurred, a major setback when up to 70% of their diet depended on these fish! In current time, dams, overfishing by settlers, and environmental impairments have prevented the Salmon from populating the streams and sustaining the Native people and other ecological inhabitants of the area (Montgomery 2005). As a result, weirs are no longer used to fish for Salmon. However, during the BTTE Camp students worked with community members to build and place a traditional fish weir in the creek; an action that is estimated to be the first time in over a 100 years to have occurred.

The stories of Bigfoot provide a way to connect children, in this case the campers, with traditional ways of their ancestors and offer an insight into the relationships, challenges, and gifts they encountered in the natural world. As such, these stories also provide an insight into the future, should the efforts of tribal organizations to return Salmon to this geographic location become successful. This is a feat considered possible and likely to occur within the lifetime of the youth who participated in the camp (C. Flanagan, personal communication, July 2014). Although some of the stories mentioned Bigfoot in times past, one of the community members mentioned a story of how he recently came across a site of bedded down grass in the mountains, which "smelled like garbage". Through this story, the man reminded the listeners that Bigfoot is not obsolete but still likely an inhabitant of the region. According to tribal knowledge, Bigfoot is a fellow member of the ecosystem dependent on many of the same things as humans. Bigfoot is a mirror, so to speak, of human needs.

Stories of Bigfoot are present in many Pacific Northwestern tribes (e.g. *S'cwene'y'ti* in Spokane, *Choanito* in Wenatchee, *Skanicum* in Colville, *Huppa* in Northern California). Elkanah Walker, a missionary in Washington State, is the first known non-Indian to write about the Native stories of Bigfoot in his 1840 diary. In this passage, he is referring to the Spokane Indians:

> Bear with me if I trouble you with a little of their superstitions. They believe in a race of giants, which inhabit a certain mountain off to the west of us. This mountain is covered with perpetual snow. They (the creatures) inhabit the snow peaks. They hunt and do all their work at night. They are men stealers.

> They come to the people's lodges at night when the people are asleep and take them and put them under their skins and to their place of abode without even waking. Their track is a foot and a half long. They steal salmon from Indian nets and eat them raw as the bears do. If the people are awake, they always know when they are coming very near by their strong smell that is most intolerable. It is not uncommon for them to come in the night and give three whistles and then the stones will begin to hit their houses. (Drury 1976, pp. 122–123)

Other Bigfoot stories within Pacific Northwest tribes have been documented with similar versions of the creature. Most consider Bigfoot to be very human-like and some even refer to them as a type of Indian. Although some stories, as the one above, indicate that the Bigfoot steal men, women, or children, most claim that they are benign or harmless. They are considered to be very intelligent, good at hiding (sometimes even blending in with trees or other vegetation), will indicate their presence with vocalizations or ward off potential threats by throwing stones at their perpetrator (Meldrum 2007). Many stories of Bigfoot often include the intersection with humans by means of stealing food. They appear to have a fondness for fish, either raw or dried, as well as game, but will consume plant foods as well. In this sense, Bigfoot will raid human stores of food while it is being harvested or preserved. It is interesting to note that although stories of large hominid figures have appeared in many parts of the globe including China, Tibet, and Australia, a heavy proportion of tales and sightings occur in the remote regions of the Pacific Northwest (Lozier, Aniello and Hickerson 2009).

It is beyond the scope of this paper to discuss whether Bigfoot is a real, extant organism. Certainly this discussion has generated both fascination and skepticism in the dominant society at many levels, from cult interest groups to academic anthropological inquiries. With this said, I recognize there is a level of risk in reporting the role of Bigfoot stories in dominant science education. Nevertheless, the Indigenous oral traditions of stories about Bigfoot are plentiful in the Pacific Northwest (Meldrum 2007). These stories emphasize Bigfoot as a fellow inhabitant of the land, therefore he is to be respected and cared for like all other relations in the ecosystem. With this said, "Indian thinking is inquiry into relationships and community, and it bears reminding us that the community extends beyond human relationships" (Fixico 2013, p. 7). Indigenous people affirm the role of relationships with all life, including those that the Western system may not recognize as living (e.g. rocks, geological features, water), therefore, they are not characterized or categorized as living or non-living, biotic or abiotic in the way that Western science does (Fixico 2013). From this perspective, the stories assert Bigfoot's membership in the family of relations and imbue lessons and themes about these relationships in the context of the shared land with all life. Therefore, the truth in the story need not be factual in a positivist sense, but rather provide a context for meaning. Robert Nash (2004), describes this element of truth in story:

> What makes a story true for all people in all times and places is not simply whether it can stand the test of scientific experiment … truth is what works best for the narrator and the reader in the neverending quest to find and construct narratives of meaning, both for self and others. (p. 33)

In this respect, Bigfoot's existence through story provides a context for constructing meaning about the ecosystem that is shared with other life. Bigfoot's needs reflect human needs and the needs of other organisms in the environment; therefore, including Bigfoot in the ecosystem design reflects the benefit to the entire natural and human community.

## Stories in Indigenous education

Indigenous education is a lifelong endeavor that includes honoring community not just within one's lifetime, but honoring ancestral and future communities as well. Communities are a part of the land, of which there is an "ancient understanding that Land is our first teacher and Her stories are embedded in us" (Davis 2014, p. 88). Okanogan scholar Jeanette Armstrong states "We live on the land and we use the land and, in doing so, we impact the land: we can destroy it or we can love the land and it can love us back" (2008, p. 68). She goes on to state that she thinks about her community, the land, each time a decision is made. "How is it going to impact the land? How is it going to impact our food? How is it going to impact our water? How is it going to impact my children, my grandchildren, my great-grandchildren, what's the land going to look like in their time?" (p. 71) To inform these decisions, one must have a deep connection with the land that is not only directly experienced, but also passed down through communal narrative over generations. Stories are the vehicles that convey, carry, and inform these lessons (Thomas 2005). They are "the wealth of our people; they are what give life and continuity to our existence; they are what link us with our collective past, and our collective future." (cited in Tsosie 2002, p. 303)

It is evident that stories found a way into how the youth began to understand the ecosystem of their place. From the Western perspective, the university team could only teach lessons on ecosystem dynamics limited to a Western worldview. Although situated locally, the patterns are based on cause and effect and not specific to place. For example, we can teach that riparian zones provide bank stability, reduce erosion, and increase shade, thus lowering water temperatures which in turn increase dissolved oxygen and reduce turbidity which are good for fish. However, having that information presented in context to the relationships the tribes have had with fish over countless generations, honoring ancestral knowledge and acknowledging future generations of not just humans, but of all the land and its inhabitants (including Bigfoot!) presents a far more meaningful educational experience for the youth. The youth would have created a different type of restoration plan for their creek had it not been for the cultural experiences with community members during the week of camp. It is not to say that their prior experiences with their Indigenous epistemology also did not influence the design, but the themes presented at camp were prominent in the youth's models. Fish weirs, crayfish, and most notably Bigfoot indicate that humans and the whole natural community are inextricably linked with the natural environment and all must be considered in all actions and decisions, such as the design challenge the youth were provided.

Gregory Cajete, Tewa scholar from Santa Clara Pueblo, advocates that story is urgently needed in contemporary Indigenous education at every level, including science. This includes stories that are generations-old as well as the creation of new stories. Communities are integral in the education of young people, and stories are one and the same.

> Indigenous community becomes a Story that is a collection of individual stories ever unfolding through the lives of the people who share the life of that community. This large community is always a living and animate entity, vitalized when it is nourished through the attention of its tellers and its listeners. When a story finds that special circumstance in which its message is fully received, it induces a direct and powerful understanding: this becomes a real teaching. (Cajete 1994, p. 169).

Furthermore, Cajete (2015) argues that story helps to build the personal and communal mythology that helps young people to understand their individual and collective identity.

Anishinaabe literary critic Gerald Vizenor (1989) describes these as narrative wisps that inform the day to day within Indigenous life. However, Vizenor also warns that tribal stories can be misrepresented according to the hyperrealities that non-Indigenous people have created about Indigeneity. In other words, although few would argue that stories provide insight and meaning about the world, it is easy to misunderstand or misappropriate the meanings of stories if they are not considered within the knowledge system that sustains it (Kovach 2010, p. 97). For this reason some scholars such as Dakota scholar Elizabeth Cook-Lynn suggest that intangible cultural phenomena such as storytelling must be viewed as a cultural sovereign "jurisdiction" that needs protection from appropriation (Tsosie 2002). Particularly in cases of popular culture, such as film and media, these appropriations can have far reaching implications on imagined cultural representations that are difficult to reverse. However, this notion of enacting jurisdiction over storytelling can seem "antithetical to the Anglo-American tradition of the author's autonomy to 'imagine' himself as—well, as *anything*" (Tsosie 2002, p. 301, emphasis in original). Eve Tuck and K. Wayne Yang describe that these appropriations indicate settler motives toward innocence via settler adoption fantasies—a desire "to become without becoming" (2012, p. 13). To put in another way, these appropriations allow non-Indigenous people movement to play with ideas of Indigeneity that can compound hyperrealities and move against achieving greater understanding of tribal epistemologies. Although stories may be urgently needed in education, these warnings serve as a reminder that they must be carefully considered in how they are enacted.

With respect to science education, many of the traditional stories, Bigfoot being only one example, contain embedded ecological and evolutionary knowledge (Aikenhead and Michell 2011). While this knowledge offers many parallels with respects to knowledge that has developed in the Western scientific paradigm, it should be noted that they are ultimately rooted in different philosophical frameworks. Again, this resonates with Kovach's words that it is paramount to situate the stories in the knowledge system that sustains it. Raymond Pierotti (2011) draws upon Yupiaq scholar Oscar Kawagaley's proposed questions as a way of acknowledging worldview differences within the Western science encounter with Traditional Knowledge: (1) What is real (metaphysics) (2) What can we understand (epistemology) (3) How should we behave (ethics) (4) What is pleasing to the senses (aesthetics) and (5) What are the patterns upon which we can rely (logic)? We can use these questions to guide our understanding of stories and delineate between worldviews and knowledge systems.

An additional way to consider the implementation of stories is to also recognize that Indigenous stories do not follow the typical linear temporal narrative of Western culture, but instead are fixed to place (Basso 1996). With that said, it can be argued that the stories must be told in the very places they are situated in. In this way, listeners espouse a corporal connection to the land in which the story is about by engaging the senses–feeling the wind, smelling the plants, hearing the water (Davis 2014). This engagement is in stark contrast to what most children experience in the walled confines of their indoor classrooms. However, when the storyteller and listener are situated in place, they are in relationship with each other and with place. They become part of the communal narrative that is the story.

## Relationship, responsibility, and renewal

Stories have a central role in Indigenous education, both historically and in current times (Cajete 2015). Because Indigenous ways of knowing are steeped in relationships that transcend human-to-human forms (Fixico 2013), stories provide a way of holistically teaching

about the existence, survival, harmony and disharmony found within relationships with all life. According to Cajete (2015), ecological and mythical educations are woven together, lending to the notion that "an intimate relationship between ourselves and our environment is the essence of both our survival and our identity as a People" (p. 50). In this sense "Indigenous mythic traditions emphasize a mutual, reciprocal relationship with the natural world. Therefore, our vast mythic legacies are ready to be used to sustain us, as they have done for generations" (Cajete 2015, p. 104, emphasis in original). This statement carries the urgent message that Indigenous stories transmit a way of life that is meaningful in context to places that have shaped the cultures of Native People for millennia. In the case of Bigfoot, the stories told during the summer camp of 2013 resonated with students in that this mutual, reciprocal relationship was highlighted in the student's ideals of an environment that could support healthy fish populations. In turn, these fish and other connecting ecological factors hold great hope towards restoration and sovereignty for these communities. Thus the ability to support humans and Bigfoot and the entire community holistically is of essence. Without Bigfoot, the story of the place would be incomplete.

I recently learned that the Indigenous people of Bhutan have stories about a large mountain-dwelling hominid creature similar to Bigfoot called Migoi. The stories of Migoi are decreasing as the recent construction of a hydroelectric plant has made electricity more attainable and prevalent in Bhutanese homes, schools, and businesses (Beveridge 2015). Because people are spending more time indoors and less time in the mountains, there are fewer opportunities for encounters, thus fewer stories shared amongst the community of such a creature. Although this does not mean that there is a loss of connection to land, it does indicate that the relationship to land is changing. With those changes, the communal story also changes. With this, I see the importance of story even more. If "stories remind us of who we are and of our belonging… hold[ing] within them knowledges while simultaneously signifying relationships", (Kovach 2010, p. 94) then I understand Cajete's urgent plea for stories within education—within place—all the more.

After the 2013 camp, the university team met weekly with a tribal community member to gain a better understanding of place. She guided us toward gaining greater cultural competency in research, including the recognition of original territory, creation stories, ancestral background, and our journey to this place. She also invited us to recognize the privilege of being researchers with badly needed grant funds brought into a community to address educational inequity/ineffectiveness. She challenged us to be aware of the responsibilities that come with such privileges.

After we went through this process, we began planning for the 2014 summer camp. This time, we focused on celebrating place and the land. We acknowledged the ancestors, thought of the future, and honored the entire natural and human community and the responsibilities associated with being a member of that community. We addressed how STEM could be used as a tool toward those responsibilities. When I walked the creek in the spring, the site where we would again hold the camp, I saw it with fresh eyes. The ground was spongy from the spring rains and run-off, young plants were emerging, and the creek swift. I saw a fawn suddenly spring up before me and run off from the safety of its grassy cover. This to me was symbolic of renewal and rebirth. We were starting again, focusing this time on the place, the land, the relationships with it that transcend time, and attuning to our personal relationships and responsibilities.

Throughout my journey, I have come to understand that STEM programs with Indigenous students go far beyond providing discrete components of Western STEM and Indigenous culture. The integration of Bigfoot stories into ecological restoration models provides one example of how storied traditions influence knowledge systems of place. Even

more, I have come to understand my own story: that I am influenced by my own worldviews, but can now appreciate other knowledge systems and acknowledge that they take time and patience to know and understand. It is my personal responsibility to be aware of other knowledge systems and ensure that I do not allow the dominant system to stronghold my actions in suppressing them. This is easier said than done.

I have two pieces of Bigfoot paraphernalia to remind me of this responsibility: one is a bumper sticker that reads, "I am pro-Sasquatch and I vote" and the other is a magnet that reads, "Remember, this forest is the home of Bigfoot". The bumper sticker is a play on Washington State voters who support salmon recovery efforts with "I'm pro-salmon and I vote". I see the Sasquatch slogan taking the recovery efforts a step further, because if I am pro-Sasquatch, then I am committed to policy that ensures protection for Sasquatch, such as habitat preservation that also favors salmon recovery. In this way, it is about the community rather than the resource. It also means that I am pro-community and pro-youth, as I believe the youth who participated in the BTTE summer camp incorporated Bigfoot into their restoration designs with community in mind. They are the next generation of stewards of the land, and I cannot ignore the knowledge that influences their understanding of that stewardship. I am also pro-Indigenized education, which centers Indigenous knowledge systems and ontologies at their core. Westernized concepts and educational practices are not necessarily excluded from this model, but carefully considered from an Indigenous framework in the reasons why and how they should be incorporated. Finally, by being pro-Sasquatch, I am also pro-knowledge systems outside of my own. Bigfoot pushed me to realize that the Western system is far from the only way. Remember, this forest is the home of Bigfoot. Remember, you are not the only one. Remember, you are a trespasser. Remember, you have responsibilities. Remember, there is much you do not know.

It is our responsibility as educators to understand what cultural relevance means and to challenge the cognitive imperialism of the modern education system. The only way we can do this is through cultural competence, humility, and genuinely getting to know our neighbors. It is our responsibility to examine knowledge-power relations and how we are a part of the larger system. It is also our responsibility to challenge those systems. Indigenous youth are not a cog in the Western education system. Their education should work for them. By providing students educational opportunities that honor and privilege their own worldviews, students can develop a rich understanding of their place and their responsibilities to it, including STEM concepts, in culturally-meaningful ways.

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## References

Aikenhead, G., & Michell, H. (2011). *Bridging cultures: Indigenous and scientific ways of knowing nature*. Don Mills, Ontario: Pearson Education.

Archibald, J. A. (2001). Editorial: Sharing aboriginal knowledge and aboriginal ways of knowing. *Canadian Journal of Native Education, 25,* 1–5.

Archibald, J. A. (2008). *Indigenous storywork: Educating the heart, mind, body, and spirit*. Vancouver: UBC Press.
Armstrong, J. (2008). An Okanagan worldview of society. In M. Nelson (Ed.), *Original instructions: Indigenous teachings for a sustainable future* (pp. 66–74). Rochester: Bear & Company.
Bang, M., Curley, L., Kessel, A., Marin, A., Suzukovich, E. S., III, & Strack, G. (2014). Muskrat theories, tobacco in the streets, and living Chicago as Indigenous land. *Environmental Education Research, 20,* 37–55. https://doi.org/10.1080/13504622.2013.865113.
Bang, M., Warren, B., Rosebery, A. S., & Medin, D. (2013). Desettling expectations in science education. *Human Development, 55,* 302–318. https://doi.org/10.1159/000345322.
Basso, K. H. (1996). *Wisdom sits in places: Landscape and language among the Western Apache*. Albuquerque: UNM Press.
Battiste, M. A. (2013). *Decolonizing education: Nourishing the learning spirit*. Saskatoon: Purich Publishing.
Beveridge, C. (2015). Why don't people see the yeti any more? *BBC World Service, Bhutan*. Retrieved from http://www.bbc.com/news/magazine-34448314. Accessed 24 May 2016.
Cajete, G. (1994). *Look to the mountain: An ecology of indigenous education*. Durango, CO: Kivaki Press.
Cajete, G. (2015). *Indigenous community: Rekindling the teachings of the seventh fire*. St. Paul, MN: Living Justice Press.
Davis, J. (2014). Towards a further understanding of what Indigenous people have always known: Storytelling as the basis of good pedagogy. *First Nations Perspectives: The Journal of the First Nations Education Resource Centre Inc., 6,* 83–96. Retrieved from www.mfnerc.org/fnp. Accessed 3 May 2016.
Drury, C. M. (1976). *Nine years with the Spokane Indians: The diary, 1838–1848, of Elkanah Walker* (Vol. 13). Norman: Arthur H. Clark Company.
Fixico, D. (2013). *The American Indian mind in a linear world: American Indian studies and traditional knowledge*. London: Routledge.
Grande, S. (2015). *Red pedagogy: Native American social and political thought*. Lanham: Rowman & Littlefield.
Gruenewald, D. A. (2003). Foundations of place: A multidisciplinary framework for place-conscious education. *American Educational Research Journal, 40,* 619–654. https://doi.org/10.1159/000345322.
Hackling, M. W. (2016). Think Piece: Preparing today's children for the workplaces of tomorrow: The critical role of STEM education. *International Journal of Innovation in Science and Mathematics Education*, *23*, 61–63.
Hooks, B. (1994). *Teaching to transgress*. New York: Routledge.
Kawagley, O. (2010). Alaska Native education: History and adaptation in the new millenium. In R. Barnhardt & O. Kawagley (Eds.), *Alaska Native education: Views from within* (pp. 73–98). Fairbanks, AK: University of Alaska Fairbanks.
Kovach, M. E. (2010). *Indigenous methodologies: Characteristics, conversations, and contexts*. Toronto: University of Toronto Press.
Lozier, J. D., Aniello, P., & Hickerson, M. J. (2009). Predicting the distribution of Sasquatch in western North America: Anything goes with ecological niche modeling. *Journal of Biogeography, 36,* 1623–1627. https://doi.org/10.1111/j.1365-2699.2009.02152.x.
Lynch, S. (2000). *Equity and science education reform*. New Jersey, PA: Lawrence Erlbaum Associates, Publishers.
Meldrum, J. (2007). *Sasquatch: Legend meets science*. London: Macmillan.
Montgomery, D. R. (2005). *King of fish: The thousand-year run of salmon*. New York: Basic Books.
Museus, S. D., Palmer, R. T., Davis, R. J., & Maramba, D. (2011). *Racial and ethnic minority student success in STEM education: ASHE higher education report*. New York: Wiley.
Nash, R. J. (2004). *Liberating scholarly writing: The power of personal narrative*. New York, NY: Teachers College Press.
National Science Foundation, National Center for Science and Engineering Statistics. (2017). Women, minorities, and persons with disabilities in science and engineering. Special Report NSF 17–310. Arlington, VA. Retrieved June 3, 2018, from https://www.nsf.gov/statistics/wmpd/.
Office of the Chief Scientist. (2014). *Science, technology, engineering and mathematics: Australia's future*. Australian Government.
Pierotti, R. (2011). *Indigenous knowledge, ecology, and evolutionary biology*. New York, NY: Routledge.
Potts, K. L., & Brown, L. (2015). Becoming an anti-oppressive researcher. In L. Brown & S. Strega (Eds.), *Research as resistance: Revisiting critical, Indigenous, and anti-oppressive approaches* (2nd ed., pp. 17–31). Toronto, ON: Canadian Scholar's Press.

Thomas, R. (2005). Honouring the oral traditions of my ancestors through storytelling. In L. Brown & S. Strega (Eds.), *Research as resistance—Critical, Indigenous and anti-oppressive approaches* (pp. 237–254). Toronto: Canadian Scholars Press.

Tsosie, R. A. (2002). Reclaiming Native stories: An essay on cultural appropriation and cultural rights. *Arizona State Law Journal, 34,* 299.

Tuck, E., & Yang, K. W. (2012). Decolonization is not a metaphor. *Decolonization: Indigeneity, Education & Society, 1,* 1–40.

Vizenor, G. R. (Ed.). (1989). *Narrative chance: Postmodern discourse on Native American Indian literatures*. Norman: University of Oklahoma Press.

Weeks, P. (Ed.). (2002). *"They made us many promises": The American Indian experience 1524 to the present*. Wheeling: Wiley.

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